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(54)【発明の名称】内視鏡用光学繊維束

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【特許請求の範囲】

無補正 【請求項１】多数の光学繊維が可撓性の外皮チューブにより略全長にわたって被覆されて、そのチューブ内部に潤滑剤が封入され、内視鏡の可撓管内に挿通されてその可撓管の先端に一端部が取着された内視鏡用光学繊維束において、

上記光学繊維を固く束ねた状態の断面積ｓが、上記外皮チューブの断面を円形にしたときのチューブ内腔の断面積Ｓに対して、

0.55S≦ｓ≦0.69Sの範囲にあることを特徴とする内視鏡用光学繊維束。

【請求項２】上記光学繊維を固く束ねた状態での断面積ｓが、上記外皮チューブ内腔の断面積Ｓに対して、0.59S≦ｓ≦0.64Sの範囲にある特許請求の範囲第１項記載の内視鏡用光学繊維束。

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【請求項３】上記潤滑剤が、内視鏡用光学繊維束の先端部付近では他の部分に比較して多量に封入されている特許請求の範囲第１項又は第２項記載の内視鏡用光学繊維束。

【請求項４】上記潤滑剤が、内視鏡用光学繊維束の両端部付近では他の部分に比較して多量に封入されている特許請求の範囲第１項又は第２項記載の内視鏡用光学繊維束。

【請求項５】上記潤滑剤が、各光学繊維に塗布されている特許請求の範囲第１項又は第２項記載の内視鏡用光学繊維束。

【発明の詳細な説明】

［産業上の利用分野］

illuminating

この発明は、内視鏡の観察用又は照明用に用いられる内視鏡用光学繊維束に関するもので、特に、光学繊維束に

optical fiber bundle

適度の柔軟性と適度の硬さを併せて持たせることにより、耐久性を向上させた内視鏡用光学繊維束に関するものである。

［従来の技術］

一般に、内視鏡用光学繊維束は可撓性の外皮チューブによって被覆されており、そのチューブ内径の太さが光学繊維束の太さに対して余裕が少ないと、チューブを被覆したとき全体が棒のように硬くなって、曲げなどにより光学繊維が非常に折れ易くなってしまう。そこで従来は、光学繊維を固く束ねた状態の断面積ｓが、外皮チューブの断面を円形にしたときの内腔の断面積Ｓに対して約２分の１、即ちｓ＝0.50S程度になるように余裕をとっていた。

［発明が解決しようとする問題点］

上記の従来の内視鏡用光学繊維束は、ｓ＝0.50Sになる程度の余裕をとっていたので、光学繊維束に外皮チューブを被覆したとき、全体が柔軟で、スムーズに曲がり易い。しかし、第４図に示されるように、内視鏡の可撓管ａ又はその先端に形成された屈曲自在な湾曲部ｂが小さな曲率半径で曲げられたときに、光学繊維束ｃがカーブの内側になると、図のように光学繊維束ｃがアコーデオンのように小さく折り曲げられて座屈してしまい、これがくり返されることによって繊維が折れ、観察や照明に支障が生じていた。

本発明は、従来のそのような欠点を解消し、曲げに対して折れ難く、しかも湾曲部内等で座屈が生じ難い、耐久性の優れた内視鏡用光学繊維束を提供することを目的とする。

［問題点を解決するための手段］

上記の問題点を解決するため、発明者が鋭意研究を行った結果、従来の内視鏡用光学繊維束に座屈が生じて光学繊維が折れるのは、光学繊維束が全体に柔軟すぎて、腰が弱いためであり、光学繊維束に適度の柔軟さと適度の腰の強さを併せ持たせることにより、繊維の折れが著しく減少することを見出し、本発明に到達した。

第１図は本発明による内視鏡用光学繊維束であり、光学繊維束10は、多数の光学繊維11…が可撓性の外皮チューブ13により略全長にわたって被覆されて、そのチューブ13内部に潤滑剤14が封入されており、内視鏡の可撓管内に挿通されて、その可撓管の先端に一端部が取着されている。そして、上記光学繊維11…を固く束ねた状態の断面積ｓが、上記外皮チューブ13の断面を円形にしたときのチューブ内腔の断面積Ｓに対して、0.55S≦ｓ≦0.69Sの範囲にあることを特徴とする。

［作用］

ｓ≦0.69Sとしてので、光学繊維束が適度の柔軟性をもち、外力が加わると光学繊維束はスムーズにカーブする。また、Ｓ≧0.55Sとし、光学繊維束が適度の腰の強さを有しているので、内視鏡の湾曲部内などでそのカーブの内側になった時にも、アコーデオン状に小さく折れ曲って座屈せず、第５図に示すごとく比較的なめらかな形状を維持することができる。

［実施例］

本発明の第１の実施例を第１図ないし第３図にもとづいて説明する。

第３図は本発明の内視鏡用光学繊維束が組み込まれた内視鏡の全体概略図であり、対物レンズ１が内蔵された先端構成部２が可撓管３の先端に取着されており、その可撓管３の基端は各種操作装置が設けられた操作部４に連結されている。そして、可撓管３の先端部分には遠隔操作により自在に屈曲させることができる湾曲部3aが形成されており、その屈曲操作をする操作ノブ4aが操作部４に設けられている。操作部４には接眼レンズ５が内蔵された接眼部６が取着されると共に、光源装置（図示せず）に接続されるコネクタ７を先端に取着した連結可撓管８の基端が連結されている。

そして、上記可撓管３内には、像伝送用光学繊維束10と照明用光学繊維束20の２種類の内視鏡用光学繊維束が挿通されており、像伝送用光学繊維束10の先端は上記先端構成部２において対物レンズ１の結像位置に取着され、他端は接眼レンズ５の観察位置に配設されている。また照明用光学繊維束20先端は上記先端構成部２に取着され、他端は上記コネクタ７の端部に取着されている。

第１図は上記像伝送用光学繊維束10の側面断面図であり、例えば直径0.01㎜の光学繊維11…が数千ないし数万本束ねられその両端部は光学繊維11…を隙間なく固く束ねた状態で口金12,12内に挿入固着されている、尚、像伝送用光学繊維束10の両端面ではその繊維の配列が互いに完全に一致しており、一端面から入射した光線が他端面に伝送される。13は例えば薄肉のシリコンゴムチューブよりなり像伝送用光学繊維束10を略全長にわたって被覆する可撓性の外皮チューブであり、このチューブ13の両端は各々上記口金12,12に接合されている。

その外皮チューブ13内では各光学繊維11…は互いに接着等されず、いわばほぐされた状態であり、外皮チューブ13内には例えば２硫化モリブデンの微粒子などよりなる潤滑剤14が封入され、光学繊維11…相互間の摩擦を減らしている。そして、その潤滑剤14は、像伝送用光学繊維束10の先端部付近10aでは他の部分に比較して多量に封入されている。こうすることにより、内視鏡の湾曲部3a内などで受けるくり返し曲げに対しての耐久性が向上する。尚、像伝送用光学繊維束10の先端部付近10aだけでなく、基端部付近10bにも潤滑剤14を多量に封入してもよく、内視鏡組立中における光学繊維の折れ発生を減らす等の効果が得られる。

また、本実施例による潤滑剤14は単に外皮チューブ13内に封入されているだけでなく、例えばハケなどによって、あるいは揮発性の液体と混ぜ合わせるなどして各光学繊維11…に直接塗布された後、その状態で外皮チューブ13内に封入されている。単に潤滑剤14を封入しただけ

では、部分的に光学繊維どうしが直接接触し、くり返し曲げなどによって簡単に繊維が折れてしまう場合があるが、このような各光学繊維11…に潤滑剤14を直接塗布しておくことにより、そのような不具合を完全に防止することができる。

照明用光学繊維束20は光学繊維の配列が両端部において互いに一致していないだけで、他は像伝送用光学繊維束10と同じ構成であり、その詳細な説明は省略する。

第2図は、上記像伝送用光学繊維束10の口金12部の断面図（A）、及び外皮チューブ13に外装された部分の断面図（B）である。そして、d及びsは口金12内における光学繊維11…の固く束ねられた部分の直径と断面積であり、D及びSは上記外皮チューブ13の断面を円形にしたときのチューブ内腔の直径と断面積である。

本実施例においては、可撓管の直径が5mmの気管支用内視鏡内に、端部の外径d＝1mm（s＝0.785mm²）の像伝送用光学繊維束及びその他通常の内蔵物を挿入して、湾曲部を上下に各180度ずつ10000回くり返し曲げる試験を、像伝送用光学繊維束の外皮チューブの寸法を種々変えて行ない、像伝送用光学繊維束の繊維の折れの状態を調べた。

その結果を次に記す。

外皮チューブ　　繊維折れ
D＝1.50mm（s＝0.44S）：▲
D＝1.40mm（s＝0.51S）：▲
D＝1.35mm（s＝0.55S）：○
D＝1.30mm（s＝0.59S）：○
D＝1.25mm（s＝0.64S）：○
D＝1.20mm（s＝0.69S）：○
D＝1.15mm（s＝0.76S）：●

（注）○：繊維折れが全く又はほとんど無い。
▲：折れが増加し実用上支障が出る。
●：折れが激増し使用に耐えられない。

［実施例2］

次に、可撓管の直径が10mmの十二指腸用内視鏡内に、端部の外径d＝2mm（s＝3.14mm²）の像伝送用光学繊維束及びその他通常の内蔵物を挿入して、湾曲部を上下に各140度ずつ左右に各100度ずつ10000回くり返し曲げる試験を、像伝送用光学繊維束の外皮チューブの寸法を種々変えて行ない、像伝送用光学繊維束の繊維の折れの状態を調べた。

その結果を次に記す。

外皮チューブ　　繊維折れ
D＝3.0mm（s＝0.44S）：
D＝2.8mm（s＝0.51S）：▲
D＝2.7mm（s＝0.55S）：○
D＝2.6mm（s＝0.59S）：○
D＝2.5mm（s＝0.64S）：○
D＝2.4mm（s＝0.69S）：△
D＝2.3mm（s＝0.76S）：

（注）○：繊維折れが全く又はほとんど無い。
△：少し折れるが実用上全く支障がない。
▲：折れが増加し実用上支障が出る。
：折れが激増し使用に耐えられない。

［実施例3］

次に、可撓管の直径が14mmの大腸用内視鏡内に、端部の外径d＝3mm（s＝7.07mm²）の像伝送用光学繊維束及びその他通常の内蔵物を挿入して、湾曲部を上下左右に各180度ずつ10000回くり返し曲げる試験を、像伝送用光学繊維束の外装チューブの寸法を種々変えて行ない、像伝送用光学繊維束の繊維の折れの状態を調べた。

その結果を次に記す。

外皮チューブ　　繊維折れ
D＝4.50mm（s＝0.44S）：●
D＝4.20mm（s＝0.51S）：▲
D＝4.05mm（s＝0.55S）：△
D＝3.90mm（s＝0.59S）：○
D＝3.75mm（s＝0.64S）：○
D＝3.60mm（s＝0.69S）：△
D＝3.45mm（s＝0.76S）：●

（注）○：繊維折れが全く又はほとんど無い。
△：少し折れるが実用上全く支障がない。
▲：折れが増加し実用上支障が出る。
●：折れが激増し使用に耐えられない。

尚、上記各実施例においては、内視鏡用光学繊維束として像伝送用光学繊維束について検討したが、本発明はこれに限定されるものではなく、上記各実施例の結果を照明用光学繊維束に適用してもよい。

［発明の効果］

本発明の内視鏡用光学繊維束によれば、光学繊維束が外力によりスムーズにカーブする程度の適度の柔軟性と、アコーデオン状に小さく折り曲って座屈しない程度の適度な腰の強さを併せて有しているので、内視鏡の可撓管内などでくり返し曲げられても、光学繊維が折れ難く、非常に耐久性に優れてる。

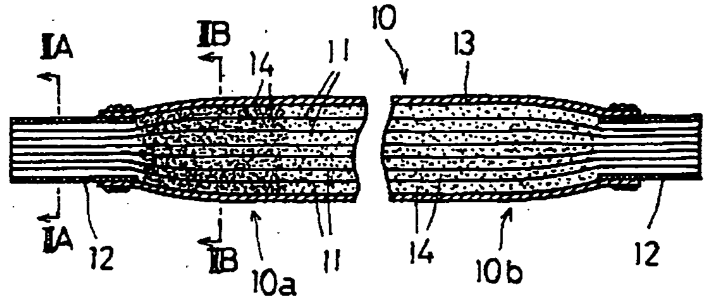
また、外皮チューブがだぶつかないので、外皮チューブが湾曲部などで挟まれて破れたりするようなことがなく、この面からも耐久上優れている。

【図面の簡単な説明】

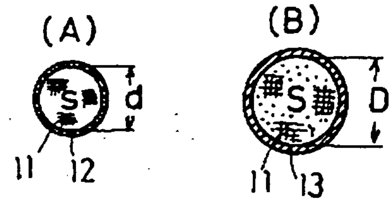
第1図は本発明の一実施例の像伝送用光学繊維束の側面断面図、第2図はそのII A－II A線及びII B－II B線切断面図、第3図は本発明の内視鏡用光学繊維束が組み込まれた内視鏡の全体概略図、第4図は内視鏡の可撓管に挿入された従来の内視鏡用光学繊維束を示す略示図、第5図は内視鏡の可撓管内に挿入された本発明の内視鏡用光学繊維束を示す略示図である。

3……可撓管、10……像伝送用光学繊維束、
11……光学繊維、13……外皮チューブ、
14……潤滑剤、20……照明用光学繊維束

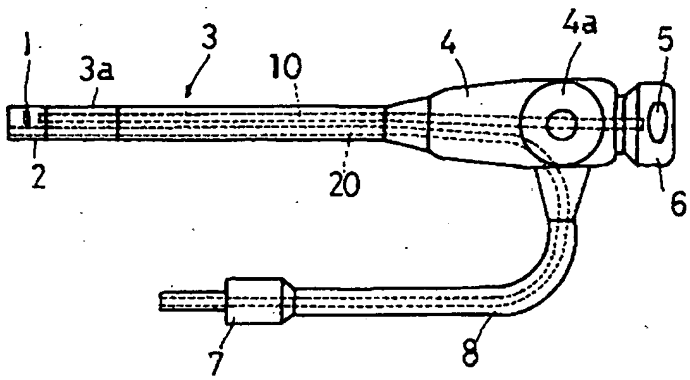
【第1図】



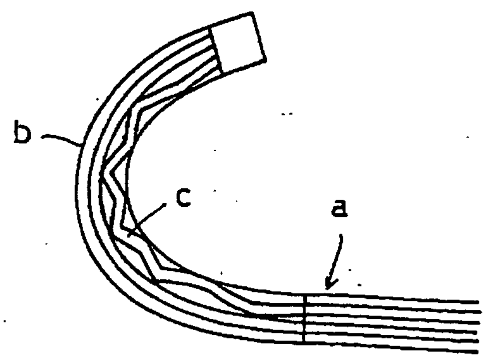
【第2図】



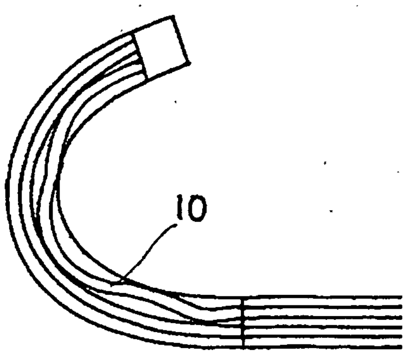
【第3図】



【第4図】



【第5図】



Date: February 18, 2002

Declaration

I, Michihiko Matsuba, President of Fukuyama Sangyo Honyaku Center, Ltd., of 16-3, 2-chome, Nogami-cho, Fukuyama, Japan, do solemnly and sincerely declare that I understand well both the Japanese and English languages and that the attached document in English is a full and faithful translation, of the copy of Japanese Patent Publication No. Hei-6-17945 published on March 9, 1994.

M. Matsuba

Michihiko Matsuba

Fukuyama Sangyo Honyaku Center, Ltd.

PROTECTIVE DEVICE FOR ENDOSCOPE-OPTICAL FIBER BUNDLE

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Inventor: Kiyoharu MIURA, et al.

Applicant: Asahi Kogaku Kogyo Kabushiki Kaisha

Patent Attorney: Kunio MIURA

SPECIFICATION

[TITLE OF THE INVENTION] PROTECTIVE DEVICE FOR ENDOSCOPE-OPTICAL FIBER BUNDLE

[WHAT IS CLAIMED IS:]

1 In an endoscope having an optical fiber bundle to be inserted into an insertion hose having a tip, a bendable hose, and a flexible hose in order from a tip side through the tip, the bendable hose, and the flexible hose, a protective device used for the optical fiber bundle, the protective device characterized in that it comprises:

a thin-walled tube with which the optical fiber bundle is covered over the whole length thereof;

a mouthpiece fixed to both ends of the thin-walled tube

and the optical fiber bundle, for joining them together;

a spiral tube with which the thin-walled tube is covered, the spiral tube being located in a part of the tip, the bendable hose, and the flexible hose of the insertion hose and being formed in such a way as to wind a cross-sectionally flat metal spirally;

a net-like tube with which an outer periphery of the spiral tube is covered, one end of the net-like tube being fixed to the mouthpiece on the tip side, the other end thereof being located in the flexible hose; and

a flexible tube with which an outer periphery of the other end of the net-like tube and an outer periphery of the thin-walled tube are covered, the flexible tube having an elastic force shrinkable in a radial direction by which the other end of the net-like tube is brought into close contact with the thin-walled tube.

2 The protective device for the endoscope-optical fiber bundle according to Claim 1, characterized in that the thin-walled tube, the spiral tube, the net-like tube, and the flexible tube are joined together with a flexible adhesive.

3 The protective device for the endoscope-optical fiber bundle according to Claim 1 or Claim 2, characterized in that a material of the net-like tube is tungsten.

[DETAILED DESCRIPTION OF THE INVENTION]

a. Technical Field

The present invention relates to a protective tube for an optical fiber bundle contained in an insertion hose of an endoscope that is used while being inserted in a body cavity or in a machine.

b. Prior art and its problem

An optical fiber bundle contained in an insertion hose of an endoscope usually has its outer periphery covered with a thin-walled tube made of a flexible synthetic resin since the fiber bundle is extremely weak.

However, some parts of an optical fiber bundle, a forceps channel tube, an air supply tube, a water supply tube, etc., that are contained in the bendable hose and that are located on the side of the outer periphery with respect to a neutral axis of the bendable hose are pulled whereas some parts of them that are located on the side of the inner periphery with respect to the neutral axis thereof are pushed when bending a bendable hose, which is a constituent part of the insertion hose, by rotating a bending operation knob provided at an operating part connected to an end of a flexible hose the other end of which is connected to the bendable hose. Additionally, although the forceps channel tube, the air supply tube, the water supply

tube, etc., are flexible, they are liable to move further toward the inner periphery as shown in FIG. 3 when bent, because they have an elastic force by which a straight condition is kept.

Therefore, the optical fiber bundle contained in the tube is pulled or pushed and is squeezed between the inner circumferential surface of the bendable hose and the forceps channel tube, the air supply tube, or the water supply tube when bending the bendable hose by rotating the bending operation knob. Usually, this operation is repeatedly carried out in an endoscopic examination, and therefore optical fibers break. As a result, an illumination light quantity for observation decreases in an optical fiber bundle for illumination, and, in an optical fiber bundle for observation, a black spot appears in an observation image from an eyepiece connected to the operating part, thus badly impairing the properties inherent in the endoscope, and making the endoscope unusable.

A possible solution to this problem is to provide a means for enlarging the wall thickness of the thin-walled tube made of synthetic resin with which the optical fiber bundle is covered, but this is insufficient to protect the optical fiber bundle because this tube uses a flexible material such as silicon.

As another means, Japanese Unexamined Utility Model No. Sho-57-120003 makes the proposition that the outer periphery of a thin-walled tube is covered with a net-like tube woven out of cross-sectionally flat materials, but, the net-like tube has the property of easily being shrunk in the radial direction when pulled in the axial direction and easily being expanded when pushed, and has the property of also having weak resistance to the pressure in the radial direction (collapsing). Therefore, this has been insufficient to protect the optical fiber bundle.

c. Object

The present invention has been made to solve the aforementioned problems, and aims to provide a protective tube capable of infallibly protecting an optical fiber bundle contained in an endoscope and capable of improving the durability greatly.

d. Summary of the invention

In the present invention, attention is paid to the fact that an insertion hose of the endoscope is comprised of a tip, a bendable hose, and a flexible hose, and the protective structure of an optical fiber bundle is changed in range from the tip and the bendable hose to the flexible hose, for which a more desirable protective form is obtained.

In more detail, the present invention is characterized by, in an endoscope having an optical fiber bundle to be inserted through a tip, a bendable hose, and a flexible hose of an insertion hose, a thin-walled tube with which the optical fiber bundle is covered over the whole length thereof; a mouthpiece fixed to both ends of the thin-walled tube and the optical fiber bundle, for joining them together; a spiral tube with which the thin-walled tube is covered, the spiral tube being located in a part of the tip, the bendable hose, and the flexible hose of the insertion hose and being formed in such a way as to wind a cross-sectionally flat metal spirally; a net-like tube with which an outer periphery of the spiral tube is covered, one end of the net-like tube being fixed to the mouthpiece on the tip side, the other end thereof being located in the flexible hose; and flexible tube with which an outer periphery of the other end of the net-like tube and an outer periphery of the thin-walled tube are covered, the flexible tube having an elastic force shrinkable in a radial direction by which the other end of the net-like tube is brought into close contact with the thin-walled tube.

That is, the net-like tube with which the spiral tube is covered has its one end fixed to one mouthpiece of the tip, and the other end thereof is merely covered with the flexible

tube in the flexible hose and is brought into contact with the thin-walled tube by a shrinkage-elastic force in the radial direction of the flexible tube without being firmly joined to the other mouthpiece.

e. Embodiment of the invention

An embodiment of the present invention will be hereinafter described with reference to the drawings.

FIG. 1 is a partially sectional side view of the embodiment of the present invention. An optical fiber 2 whose single-fiber diameter is about 8 to 40μ is covered with a thin-walled tube 3 made of about 3,000 to 50,000 strands of silicon, and mouthpieces 4 and 5 are fixed to the optical fiber 2 with both ends of the optical fiber 2 firmly fit in the mouthpieces, respectively, with an adhesive. Both ends of the thin-walled tube 3 are fixed to the outer peripheries of the mouthpieces 4 and 5 with threads, and, especially in the mouthpiece 4 firmly joined to the tip of the insertion hose, the thin-walled tube 3 is dropped into a groove 7 disposed in the outer periphery on the rear side of the mouthpiece 4 and is fixed there with a thread 6, so that the thin-walled tube 3 is not easily disjoined from the mouthpiece 4 even when the thin-walled tube 3 is pulled.

The outer periphery on the tip side of the insertion hose

of the thin-walled tube 3 is covered with a spiral tube 8 made of a cross-sectionally flat metal so as to come in contact with the outer periphery of the thin-walled tube 3, and the outer periphery of the spiral tube is covered with a net-like tube 9 made of tungsten so as to come in contact with the outer periphery of the spiral tube 8.

One end of the net-like tube 9 is dropped into a groove 10, nearer to the tip than the groove 7 and formed in the outer periphery of the mouthpiece 4, and is fixed there with the thread 6, whereas the other end thereof is covered with a flexible tube 11 made of synthetic resin that has an elastic force shrinkable in the radial direction so as to be firmly joined to the thin-walled tube 3 and be in contact with the outer periphery of the thin-walled tube 3.

Further, the thin-walled tube 3, the spiral tube 8, net-like tube 9, and the flexible tube 11 are integrally joined together with a flexible adhesive (not shown).

FIG. 2 is a partially sectional schematic drawing that shows a state in which the optical fiber bundle 1 according to the present invention is incorporated into an endoscope 12.

An insertion hose 13 of the endoscope 12 is comprised of a tip 14, a bendable hose 15, and a flexible hose 16 that are firmly joined together, and an operating part 17 is fixed

to the other end of the flexible hose 16.

The operating part 17 is provided with an eyepiece portion 19 including an eyepiece used to enlarge and observe one end of an optical fiber bundle 18 for observation, a light guide tube 20 used to guide one end of an optical fiber bundle (not shown) for illumination to a light source (not shown) and protect it, and a bending knob 21 used to bend the bendable hose 15 by the rotational performance of an examiner.

An air supply tube (not shown) one end of which is fixed to the tip 14, a water supply tube (not shown), and a forceps channel tube 22 are contained in the insertion hose 13.

The optical fiber bundle 18 for observation and the optical fiber bundle (not shown) for illumination are contained therein as the optical fiber bundle 1, and FIG. 2 shows the optical fiber bundle 18 for observation. Further, a wire (not shown) for bending the bendable hose 15 by rotating the bending knob 21 is fixed to the tip of the bendable hose 15 and is contained, and one end of a coil (not shown) for protecting the wire is fixed to a connection part between the bendable hose 15 and the flexible hose 16 and is contained.

In the optical fiber bundle for illumination, the performance of the endoscope is not significantly impaired by cutting a small number of fibers thereof in comparison with

the optical fiber bundle for observation, and therefore there is a situation wherein no problems arise even if only the thin-walled tube is protected or even if a flexible adhesive is merely applied onto the outer circumferential surface of the thin-walled tube, in relation to the purpose of use of the endoscope or in relation to the filling ratio of contents with respect to the outer diameter of the insertion hose and the inner diameter of the insertion hose.

FIG. 3 is an enlarged sectional view of the insertion hose 13 on the tip side in a state in which the bendable hose 15 of FIG. 2 is bent.

The forceps channel tube 22 is flexible, but, because of its elastic force by which a straight condition is kept, it moves in the direction of arrow A, and, as a result, the optical fiber bundle 18 for observation is squeezed between the inner circumferential surface of the bendable hose 15 and the forceps channel tube.

The air supply tube and the water supply tube, not shown, move in the same way as the forceps channel tube 22.

The positions to which the net-like tube 9 and the thin-walled tube 3 are fixed are set at a position where the flexible tube 11 does not enter the bendable hose 15 even when the bendable hose 15 is bent in any direction.

In the endoscope 12 in which the thus structured optical fiber bundle 1 is contained in the insertion hose 13, when a body cavity, for example, is observed, an examiner repeatedly bends the bendable hose 15 by rotating the bending knob 21 in order to guide the endoscope 12 to an intended part of the body cavity of a subject, and leads the tip 14 to the intended part.

One end of the optical fiber 1 is fixed to the tip of the insertion hose 14, and, by a bending movement, the optical fiber bundle 1 is repeatedly pulled to the tip side or is pushed therefrom through the bendable hose 15 and the flexible hose 16. Since a conventional optical fiber bundle, including a thin-walled tube covering the optical fiber bundle, has high flexibility, its stiffness is weak, and a sag occurs in the bendable hose and in the flexible hose without being able to match the bending movement, thus causing a break in the optical fibers.

Further, as described above, since the forceps channel tube, the air supply tube, and the water supply tube in the bendable hose are urged to move toward the inner periphery of the bendable hose in the bent state, the optical fiber bundle is squeezed between the inner circumferential surface of the bendable hose and the respective tubes, thus causing a break in the optical fibers.

Further, if the optical fiber bundle is pulled while being squeezed therebetween, a tensile force is applied directly onto the optical fiber and breaks the optical fiber since the flexibility of the covering thin-walled tube is high.

In the optical fiber bundle 1 covering the protective tube structured according to the present invention, the net-like tube 9 having a relatively great change in the radial direction and the spiral tube 8 having a small change with respect to the pulling or pushing in the axial direction are integrally and firmly joined together with a flexible adhesive in a state of being in close contact with each other, and strong stiffness is shown while maintaining its flexibility, and therefore the optical fiber 2 is protected by the spiral tube 8 against a collapse without causing a sag even when a bending movement is repeatedly performed.

Further, if the outer periphery of the thin-walled tube and the end of the net-like tube are fixed together only with the flexible adhesive, the separation of the thin-walled tube and the net-like tube occurs especially from the end of the net-like tube because of friction and engagement with the inner circumferential surface of the flexible hose as a result of repetition of a back-and-forth movement in the axial direction of the optical fiber bundle through the flexible hose according

to the bending operation. This disrupts the back-and-forth movement of the optical fiber bundle and causes a break in the optical fiber, and, additionally, the strands of the disjoined net-like tube pierce through the thin-walled tube and cut the optical fiber.

In the present invention, the outer periphery of the end of the net-like tube 9 is covered with the flexible tube 11, and the thin-walled tube 3, the net-like tube, and the flexible tube 11 are integrally fixed together with the flexible adhesive, and therefore friction and engagement between the inner circumferential surface of the flexible hose 16 and the end of the net-like tube 9 are all received by the flexible tube 11, and no separation occurs.

If there is a large difference in flexibility and in the stiffness strength between a part protected by both the spiral tube 8 and the net-like tube 9 and a part protected only by the thin-walled tube, there is a possibility that the optical fiber 2 will break at this boundary. However, in the present invention, the flexibility of a part where the outer periphery of the thin-walled tube 3 is covered with the flexible tube 11 to which the end of the net-like tube 9 is fixed is between the flexibility of the part covered with both the spiral tube 8 and the net-like tube 9 and the flexibility of the part of

only the thin-walled tube 3. Therefore, a difference in the flexibility becomes small, and the optical fiber 1 is prevented from being cut at the boundary.

At a fixed part between the protective tube and the mouthpiece 4, the thin-walled tube 3 is dropped into the groove 7 and is fastened with the thread 6, and one end of the net-like tube 9 is dropped into the other groove 10 and is fastened with the thread 6. Thereby, pulling strength can be raised without increasing the diameter.

Additionally, the use of tungsten with high mechanical strength as a material of the net-like tube 9 makes it possible to obtain sufficient strength by the net-like tube 9 whose strand diameter is about ϕ0.02 mm, and therefore the optical fiber 2 can be protected without thickening the outer diameter of the protective tube of the optical fiber bundle 1.

f. Effect

As is apparent from the foregoing description, in the endoscope in which the optical fiber bundle covering the protective tube according to the present invention is contained in the insertion hose, the optical fiber does not break even when the insertion hose is inserted into a body cavity or into a machine and is repeatedly bent in order to observe an intended part, and therefore the durability of the endoscope itself can

be remarkably improved, and, in the present invention, it can be realized relatively cheaply, easily, and infallibly.

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a partially sectional side view of an embodiment of the present invention, FIG. 2 is a partially sectional schematic view that shows a state in which an optical fiber bundle according to the present invention is incorporated into an endoscope, and FIG. 3 is an enlarged sectional view of an insertion hose on the side of a tip in a state in which the bendable hose of FIG. 2 is bent.

1……optical fiber bundle, 3……thin-walled tube, 4,5……mouthpiece, 6……thread, 7,10……groove, 8……spiral tube, 9……net-like tube, 11……flexible tube, 12……endoscope, 13……insertion hose, 14……tip, 15……bendable hose, 16……flexible hose

Fig.1

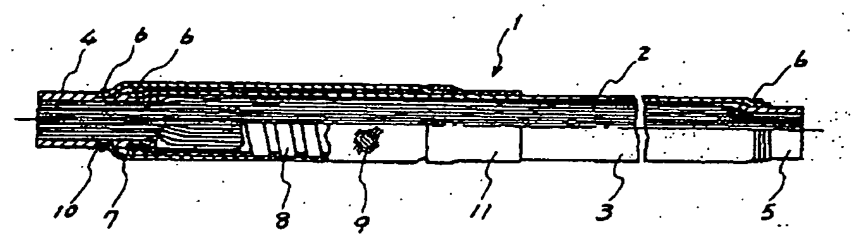

Fig.2

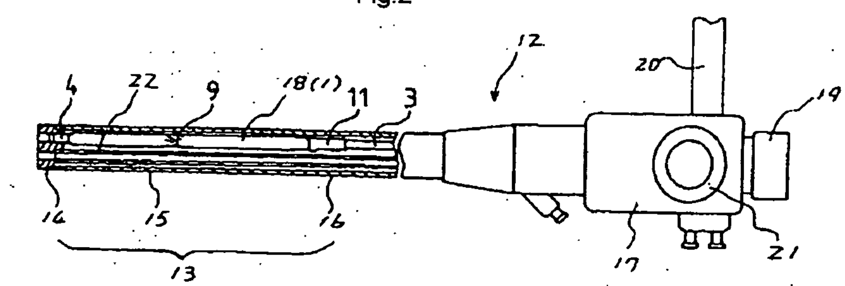

Fig.3